A Review of Integrative Approaches to Self-management of Hypertension

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Abstract

Hypertension (HTN), or high blood pressure, is a chronic condition associated with serious complications. There is a high prevalence worldwide and increasing numbers of people are diagnosed with hypertension. Antihypertensive medications are an important part of treatment of hypertension that also includes lifestyle modification including diet and exercise, yet poor control of blood pressure remains common and contributes to poor outcomes. Dietary approaches to stop Hypertension (DASH) is the most commonly recommended non-pharmacological intervention, yet since its introduction, the number of people with hypertension has increased due to a variety of factors. Alternative or complementary (integrative) interventions may be effective in reducing hypertension. The purpose of this literature review was to identify effective alternative or complementary interventions to reduce hypertension. PubMed and CINAHL were searched using predetermined set of terms and parameters. Electronic and manual searches were completed to ensure that all inclusion and exclusion criteria were applied to the selected articles. Inclusion criteria were: outcome measure of blood pressure (BP); English language; published between 2013 and 2018; either systematic review, randomized controlled trial, or meta-analysis; adult humans (18 years or older); subjects with an official diagnosis of hypertension; the intervention must be an alternative or complementary diet or behavioral intervention; and the article must be relevant to our purposes. Eighteen studies were selected for review and were categorized accordingly. Categories were behavioral intervention, dietary intervention, and combination of a dietary and a behavioral intervention. The data shows the effectiveness of integrative approaches to hypertension self-management such as taking measures to reduce stress and increase physical activity through gentle exercise techniques like tai chi and yoga, altering the diet, taking supplements such as beetroot juice, and managing stress

through stress-reduction/relaxation techniques. However, further research comparing the interventions is needed to determine the most effective non-pharmacological solutions for hypertension.

Introduction

Hypertension affects over 65 million adults in the United States alone and is associated with other chronic disorders, such as metabolic syndrome chronic kidney disease, atherosclerotic disease, and diabetes. Globally, HTN is related to approximately 7 million deaths and 64 million-disability adjusted life-years annually (Vega & Bisognano, 2014). A formal diagnosis of HTN can be made for blood pressure reading above 140/90 sustained for more than 6-8 weeks. HTN has been shown to be difficult to control and manage, contributing to a high risk of adverse effects, especially on the cardiovascular and renal systems. HTN is frequently a symptomless disease, so many are unaware of their condition. In addition, when patients finally are diagnosed with HTN and prescribed medication, the side effects often outweigh the benefits from a patient perspective. Common lifestyle factors associated with HTN are obesity, smoking, and excessive drinking (Vega & Bisognano, 2014). Because of the high prevalence of HTN, the challenges associated with controlling it, and the numerous serious sequala of HTN, a heavy strain is also placed on the healthcare system. Many medications and approaches to treating HTN are available, yet uncontrolled or medication-resistant HTN persists.

The most long-standing and very common lifestyle recommendation for HTN is the Dietary Approaches to Stop Hypertension (DASH) diet – dietary approaches to stop hypertension (Svetkey et al., 1999; Whelton & Williams, 2018), which mainly encourages dietary reduction of salt. The DASH diet is recommended by the American Heart Association as a lifestyle management intervention for hypertension (Whelton & Williams, 2018). The DASH diet was launched in 1999, and at the time was shown to significantly lower blood pressure in all groups studied and was particularly effective for African-Americans (versus Caucasians) and in hypertensive (versus normotensive) subjects (Svetkey et al., 1999). At the time of the seminal

study, 50 million Americans had hypertension (Svetkey et al., 1999) – about two decades later, there is a 30% increase in the prevalence of HTN (Vega & Bisognano, 2014). The need for effective management of HTN is higher than ever, as prevalence of HTN will only continue to rise with an aging US population and as the US continues to nutritionally and socially transition to increasingly poor dietary and lifestyle patterns.

The lifestyle change component of HTN management is particularly important since it is largely a lifestyle-associated disease, and there are increasing numbers of medication-resistant HTN. Utilizing integrative medicine could be a great way to meet the need for additional options for HTN management through lifestyle changes. According to the National Center for Complementary and Integrative Health within the National Institute of Health (2017), integrative health is defined as bringing conventional and complementary approaches together where there is evidence of safety and efficacy in a coordinated way; emphasizing a holistic, patient-focused approach to health care and wellness. Formerly defined only by alternative or complementary health, integrative health is now used as a term established by the National Institute of Health to comprehensively describe all alternative/complementary approaches due to its consistent use in recent decades and the desire to move away from terms like "alternative," which can imply care outside of or uncooperative with traditional Western medical regulation (National Institute of Health [NIH], 2017). Complementary and alternative (integrative) health is making a comeback in the US, and it offers many options for the self-management of HTN (de Sá Ferreira 2013). In this study, we explored alternative or complementary (integrative) interventions to reduce hypertension. Over the years, DASH has been tested against alternative diets and other integrative modalities for treating hypertension. The purpose of this study is to compare the current evidence of effectiveness of DASH against other integrative modalities to manage

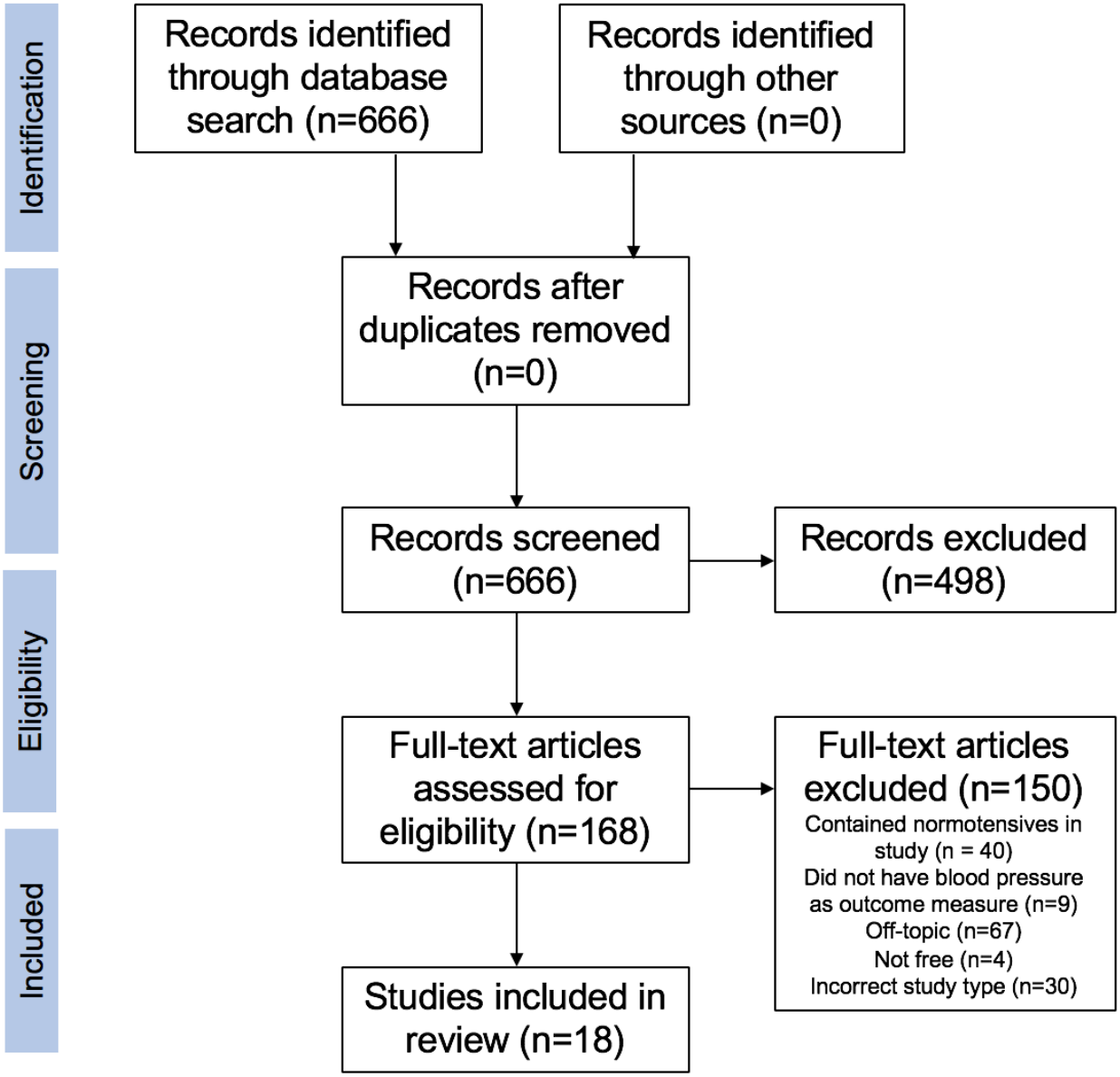
hypertension. Effectiveness of behavioral programs and/or diets paired with DASH and not paired with DASH were evaluated or compared against DASH alone. This study aimed to identify the most effective integrative interventions for HTN management that patients can largely do independently/after recommendation by a provider.

Methodology

A literature search was performed between September 2018-December 2018 using PubMed and CINAHL. Search terms used were [DASH diet AND hypertension OR high blood pressure] and [complementary intervention OR alternative intervention]. The search was limited between the years 2013 and 2018; the English and human limiters were also selected. The limiter for the type of article was also applied, and randomized controlled trial, systematic review, and meta-analysis were selected. CINAHL was searched first, which yielded 255 results. The search was limited to 2013-2018, which yielded 123 articles. Next, the human limiter was applied, which restricted the results to 64 articles. These 64 articles were then manually reviewed, and only the articles that met all of the inclusion criteria were included. After manual data extraction, 6 studies were deemed appropriate for this study. The selected search terms were then entered in PubMed, which yielded 411 results. The search was limited to 2013-2018, which narrowed the results to 162 articles. Then, a human limiter was applied which yielded 104 articles. The 104 articles were then manually reviewed to ensure all inclusion criteria were met. Blood pressure as an outcome measure and free access was required, and the topic of the studies had to be appropriate. After this manual data extraction, 12 articles were deemed appropriate for this study. The total articles that were deemed appropriate from the two databases were 18 articles (figure

1). These were entered into a literature review table for further review and categorization and were all included in the final analysis (Appendix).

Figure 1



Results

This review evaluated alternative treatments for the self-management of hypertension. The measured outcomes did not vary. The primary outcome measured was blood pressure. Results were evaluated on whether or not the intervention reduced blood pressure. Three distinct

categories of interventions to reduce blood pressure were found in the literature: dietary interventions, behavioral interventions, and a combination of dietary and behavioral interventions (Table 1). For the purposes of this review, the term "behavioral intervention" describes an intervention that necessitates a physical activity, without altering diet. Dietary interventions were considered to be strictly dietary changes or supplementation. Combination interventions incorporated both dietary and behavioral changes. A variety of types of behavioral, dietary, and combination interventions were found in the literature (Table 2).

Table 1

Type of intervention	# of studies in which intervention was effective	# of studies in which intervention showed no effect
Dietary	2	2
Behavioral	10	1
Combination (dietary and behavioral)	2	1

Table 2

Type of intervention	# of studies
Sodium restriction with coaching	1
Music	2
Physical activity and nutrition with distance health coaching	1
Stress management and dietary counseling	1
Yoga	4
Self-measured blood pressure	1
Free weight resistance training and manual resistance training	1
Circuit, endurance, and relaxation training	1
Tai chi	1
Qigong	1
Sodium restriction	1
Traditional Chinese Medicine herbs	2
Beetroot juice	1

Dietary interventions

Four articles solely based on dietary interventions were found to be appropriate for this review. One was a pilot randomized controlled trial that explored the use of Bushen qinggan, one was a meta-analysis that studied the effects of beetroot juice, and two were systematic reviews that examined salt restriction and ginkgo biloba extract (GBE). Databases used in the systematic reviews were Pubmed, Embase, Scopus, Cochrane, Central, Medline, CINAHL, Wanfang Data, and Chinese Biomedical Literature Database.

The RCT focused on the use of Bushen qinggan in both decoction and granule form as an intervention for HTN (Wu, Zhang, Zhao, Chen, & Lin, 2014). A decoction is the substance created through concentrating the essence of a plant through heating or boiling. It is a commonly used form of herbal medicine in traditional Chinese medicine (TCM). Granules are dried, packed plant material, usually medicinal herbs, also commonly utilized in TCM. Bushen qinggan is an herbal formula frequently used in clinical practice by TCM practitioners with the purpose of treating hypertension. It is composed of *Gastrodia elata* (tian ma, TM) 30g, *Uncaria* (gouteng, GT) 30 g, *Eucommia* bark (du zhong, DZ) 30 g, radix *Scutellariae* (huang qin, HQ) 15 g, and bitter butyl tea (kudingcha, KDC) 15 g (Wu, Zhang, Zhao, Chen, & Lin, 2014). It was found that the efficacy of Bushen qinggan in both decoction and granule form was similar in improving blood pressure variability and endothelial function. However, Bushen qinggan in decoction or granule form did not significantly lower blood pressure (Wu, Zhang, Zhao, Chen, & Lin, 2014). Other TCM herbal medicines such as Huang qin and Tian ma need to be explored further in research to prove or disprove their efficacy in lowering blood-pressure, since these herbs and Bushen qinggan are still commonly recommended and consumed by those who follow and practice TCM today. This also holds true for GBE, since GBE is often used by TCM physicians

and patients for the treatment of HTN, although there is uncertainty about its clinical recommendation. (Xiong et al., 2014). It is notable, however, that there are rigorous studies on Gouteng, also a commonly used TCM herbal medicine for HTN, on its antihypertensive, free-radical scavenging, and anti-excitotoxic effects (Wu, Zhang, Zhao, Chen, & Lin, 2014).

A meta-analysis of 43 RCTs focusing on the effects of beetroot juice showed that, compared with placebo, supplementation with beetroot juice might be related to significantly lower levels of both systolic blood pressure (SBP) and (DBP) (mean difference: -3.55 and -1.32 mm Hg, respectively) (Mirimiran, Kabir, Azizi, & Ghasemi, 2017). This meta-analysis also showed that individuals with higher baseline SBP values exhibited a greater decline in SBP levels after beetroot supplementation. It was also shown that beetroot juice might be particularly effective in individuals with other chronic diseases, as a greater reduction in SBP and DBP was found in nonhealthy than in healthy individuals. The best effect of beetroot juice supplementation on blood pressures was observed when the duration of the trial and follow up was less than 2 weeks. According to the authors, previous metanalyses reported only short- and medium- term blood-pressure lowering effects of beetroot juice. More rigorous studies with longer follow-up are needed to determine the true long-term effectiveness of beetroot juice supplementation.

In a systematic review by Adler, et al (2017), two studies were reviewed with participants diagnosed with hypertension. In the systematic review, salt restriction was found to reduce SBP and DBP overall in hypertensives by 2-4 mm Hg on average (Adler et al., 2017). Since these studies each had follow-up longer than six months, this suggests that interventions to reduce dietary salt are effective in lowering blood pressure long-term. This is notable, because sustained

long-term reductions of diastolic blood pressure of 1 mm Hg and 4 mm Hg are predicted to reduce cardiovascular disease mortality by 5% and 20% respectively (Adler et al., 2017).

GBE, a traditional natural herbal product, is made from the dried leaves of the Ginkgo tree and is often used in the treatment of essential hypertension as complementary therapy. The chemical composition of GBE is complex and several of its constituents (e.g. flavone glycosides and terpenoids) have been proposed as being responsible for the cardiovascular protective effects and cerebrovascular-related disorders (Xiong et al., 2014). In the systematic review on GBE (Xiong et al., 2014), several trials demonstrated potential positive effect on BP reduction when compared with antihypertensive drug therapy; however, it was not associated with a statistically significant effect on either SBP or DBP reduction in other 3 trials. Because of this, the authors concluded that there was no convincing evidence to support the routine use of GBE for hypertension.

Behavioral Interventions

Eleven articles based on behavioral interventions alone were deemed appropriate for this review. Four studies were RCTs, three were meta-analyses, and four were systematic reviews. Databases used in the systematic reviews and meta-analysis included Medline, multiple databases within the Cochrane Library, Embase, Scopus, IndMED, PubMed, Web of Science, Google Scholar, Database of Abstracts and Reviews of Effects, Allied and Complementary Medicine Database, and a number of Asian databases.

Among the randomized controlled trials that studied behavioral interventions, interventions included: yoga; manual and free weight resistance training; endurance, circuit, and relaxation training; and music. Music, self-measured blood pressure, and yoga were studied in

meta-analyses that included behavioral interventions alone; yoga, tai chi and qigong were the interventions studied in systematic reviews.

In the RCT that studied yoga, low-impact, gentle yoga movements and yoga breathing exercises were utilized alone; no dietary or other activity changes were made. Reductions in SBP, DBP, and MAP (mean arterial pressure) were found in the intervention group 24 hours after completing the yoga intervention. SBP was reduced by 5 mm Hg on average, and SBP by 4 mm Hg on average (Hagins, Rundle, Consedine, & Khalsa, 2014).

In the RCT that examined the effects of manual and free weight resistance training, the study aimed to differentiate the blood-pressure lowering effects of manual resistance training (MRT) and free weight resistance training (FWRT) and see if one achieved a better BP-lowering effect than the other. In hypertensive men, both MRT and FWRT had BP-lowering effects immediately after exercise, and one was not more effective than the other (la Scala Teixeira et al., 2017). This RCT is included in our review since it is considered a manipulative and body-based method, one of the five categories of integrative medicine (NIH, 2017).

The RCT on endurance, circuit, and relaxation training aimed to determine if circuit training or relaxation training were as effective in reducing BP as endurance training is, which has already been established as a BP-lowering behavioral intervention (Venturelli et al., 2015). While other biometric outcome measures improved in circuit training and endurance training, those in the relaxation training group still experienced the same level of blood pressure reduction and perceived improvement in quality of life. It was found that in all groups, resting BP was reduced by ~11% (Venturelli et al., 2015). This suggests that patients who experience physical limitations such as old age, obesity, or other comorbid conditions alongside hypertension may still be able to enjoy significant reductions in blood pressure through activities that are not

physically challenging or contraindicated due to other conditions. Instead of participating in endurance training, circuit training, or other BP-lowering types of physical activity, they may be able to achieve the same effect on BP through relaxation training, an intervention that does not require heavy physical activity. However, this RCT was in older adults only, so these results may not be generalizable to standard HTN management.

An RCT compared music versus lifestyle on the autonomic nervous system of prehypertensives and hypertensives using a specific component of Indian music, Ragas. Ragas is a relaxing form of music originating from India that supposedly aids in normalizing blood pressure (Kunikullaya et al., 2015). It was found that the music group experienced significant reduction in stress levels, an increase in parasympathetic activity, and some limited effects on BP. Females experienced a greater increase in parasympathetic activity than males, but there were no differences in BP changes across gender. The researchers concluded that passive listening to Indian music along with conventional lifestyle modifications has a role in normalizing BP through autonomic function modification and thus can be used as a complementary therapy along with other lifestyle interventions (Kunikullaya et al., 2015).

In the meta-analysis that examined music, nine studies evaluated the effects of recorded music and one study evaluated the effects of music therapy on BP (Kuhlmann et al., 2016). According to the American Music Therapy Association (n.d.), music therapy is defined as the clinical and evidence-based use of music interventions to accomplish individualized goals within a therapeutic relationship by a credentialed professional who has completed an approved music therapy program. On average, it was found that SBP was reduced by 10 mm Hg, and DBP by 6 mm Hg. While a cause-effect relationship could not be established, it was concluded that music interventions, such as listening to pre-recorded quiet synthesized music once a day, in treatment

of hypertension are effective and could be recommended for practice (Kuhlmann et al., 2016). The effectiveness shown in this systematic review is more robust than the previously described RCT on Ragas music, and both show promising results for music on BP within HTN.

One meta-analysis included in this review explored the effectiveness of self-measured blood pressure (SMBP) in adults with HTN. Fifty-two (52) studies were included, some of which included external support alongside SMBP and some of which did not. External support included counseling, education, and Web-based support. Regardless of participants receiving external HTN-management support or not, SMBP alone versus usual care showed a lower BP amongst subjects at 6 months (3.9 mm Hg reduction in SBP and 2.4 mm Hg reduction in DBP), but not at 12 months. When subjects received external support in combination with SMBP, the BP-lowering effects were maintained at 12 months as well (Uhlig, Patel Ip, Kitsios, & Balk, 2013).

One of the meta-analyses and two of the systematic reviews on behavioral interventions also studied yoga. One systematic review found an average effect of -10 mm Hg on SBP and -8 mm Hg on DBP (Cramer, 2016). The other systematic review found no effect on SBP, but a -2.9 mm Hg effect on DBP (Hartley et al., 2014). The meta-analysis found a 9.7 mm Hg average reduction in SBP and a 7.2 mm Hg reduction in DBP (Cramer et al., 2014). The second systematic review, which found no difference in SBP and a moderate difference in DBP was of the highest quality evidence compared to the other systematic review and meta-analysis as a Cochrane review. Heterogeneity was a significant limitation in each of the reviews, which may have contributed to the mixed evidence seen in this review regarding the effectiveness of yoga on BP of HTN patients. Notably, there are many different types of yoga, all of which might have varying effects on BP. More specific evidence on different types of yoga is needed to be able to draw conclusions about its effectiveness.

Another systematic review studied tai chi. Tai chi is a Chinese therapy evolved from a form of martial arts, and it has been described as a system of movements and postures used to enhance mental and physical health (Hartley, Flowers, Soo Lee, Ernst, & Rees, 2014). Only five of the thirteen RCTs included in the systematic review enrolled patients with HTN or pre-HTN, which is an important limitation to consider for the purposes of this review. However, the results of the systematic review on tai chi are still worth considering, since hypertensives were included in the overall sample and blood pressure was used as an outcome measure. Although significant heterogeneity existed amongst trials for effects on SBP and DBP, it was found that on average, tai chi reduced SBP by 14.5 mm Hg and DBP by 8.9 mm Hg. It also had a beneficial effect on lipid levels, another cardiovascular risk factor (Hartley, Flowers, Soo Lee, Ernst, & Rees, 2014).

In the systematic review on the effectiveness of qigong, six trials examined the effects of qigong on BP. Qigong is an ancient Chinese meditative practice used in health promotion. The three main components of qigong are mind regulation, body regulation, and breath regulation. Three of the six trials showed a reduction in SBP and two of which showed a reduction in DBP (Hartley et al., 2015). The quality of the evidence in this systematic review was low, and although about half of the studies that included BP showed a BP-lowering effect, the evidence is not sufficient enough to warrant a change in practice or recommendations for HTN-management.

Combination Interventions

Three studies out of the final sample included a combination of a dietary and a behavioral intervention. All three studies were RCTs. In one RCT, DASH was combined with traditional Chinese medicine food therapy recommendations, two classroom sessions, and a telephone booster phone call to ensure compliance and provide advice from clinicians for a group of

Chinese Canadians. The intervention was compared to a usual care group. In the intervention group, after eight weeks, a greater reduction in SBP, with an average of 3.8 mm Hg reduction in the in the intervention group, was seen compared to the usual care group. (Zou, Dennis, & Parry, 2017). While these results are not as profound as other interventions, they do suggest that culturally competent healthcare, a component of integrative medicine, might help patients better manage HTN.

Another RCT also incorporated culturally competent measures, regarding young African-American women instead of Chinese Canadians. This RCT used online educational modules for either DASH or lifestyle physical activity, mainly in the form of walking, as tools for reducing BP in African-American women with untreated prehypertension. The authors found no significant results regarding BP reduction through the use of their online modules (Staffileno, Tangney, & Fogg, 2018).

The third RCT included stress management combined with dietary counseling. The main diet that subjects were counseled on was the Mediterranean diet, which is characterized by high intake of vegetables, fruits, legumes, unrefined cereals, nuts, olive oil in lieu of saturated lipids, moderately high intake of fish, low to moderate intake of dairy, meat, and poultry, and regular but moderate consumption of red wine (Katsarou et al., 2014). The main stress management technique incorporated into the study was progressive muscle relaxation, which includes the conscious tensing and releasing of successive muscle groups while attending to the resulting differences in sensation (Charalambous et al., 2016). Participants were educated on the diet and stress management techniques and received regular counseling on their progress throughout the eight-week intervention. A significant reduction in SBP (average 7.2 mm Hg reduction) was experienced by the intervention group, as well as a 4.9 mm Hg average reduction in DBP. In the

control group, there was no effect on SBP or DBP. A reduction in perceived stress was also found in the intervention group (Katsarou et al., 2014).

Discussion

A wide variety of interventions were explored in this review, and many were found to be effective at reducing BP in hypertensive patients. Overall, behavioral and combination interventions were found to be the most effective, while dietary interventions were found to be the least effective for reducing BP in hypertensive patients. We recommend the use of music/music therapy, tai chi, sodium reduction, and stress management as effective integrative interventions for the self-management of HTN. Unlike many types of HTN medication, which can have unpleasant or serious side effects, many interventions in this review also improved other facets of health, such as cholesterol and perceived stress (Hartley, Flowers, Soo Lee, Ernst, & Rees, 2014; Katsarou et al., 2014). These favorable outcomes support the use of integrative interventions in HTN management. In patients whose HTN is not an imminent danger to their health, or in prehypertensive patients, integrative interventions could be a less costly and more acceptable option to patients as an alternative to medication therapy which has undesirable side effects. Aside from the more intense physical interventions like MRT/FRWT (la Scala Teixeira et al., 2017) that might be limited by patients' physical capabilities and clinical recommendations from providers, these interventions are generally safe to use in combination with HTN medication and may aid in further reducing blood pressure. Many of these interventions are low-cost, which reduces one of the main barriers for compliance with treatment: limited finances. These interventions are also largely self-guided, decreasing the need for clinician/expert management besides progress updates/guidance and check-ups at regular appointments. Because

of the low cost of these interventions and the little clinical time and resources that are required to recommend and monitor them, a reduction in the overall burden that HTN/HTN management has on the healthcare system might be seen if highly effective integrative interventions are utilized.

Many of the most effective interventions (such as stress reduction and dietary counseling and music) are focused on relaxation/stress reduction, and many studies theorized that the reduction in BP seen from these interventions was due to the parasympathetic-inducing effects of the intervention. The ability to reduce sympathetic activity and promote relaxation through activation of the parasympathetic nervous system was the most commonly theorized explanation for blood pressure reduction amongst behavioral or combination studies within this review. While understanding the most effective blood-pressure reducing integrative interventions is important and may guide future practice, recommendations, and research, it is important to note that stress-reducing activities in general tend to have a significant effect on lowering the BP of hypertensive patients. Because of this noted effectiveness of many of the various stress-reducing interventions, perhaps patients would benefit from creating an individualized stress-reduction plan with their appropriate clinician. This would be a relatively easy next step to facilitate in hypertension management while the most effective integrative lifestyle interventions are still being identified and established in practice.

In many of the studies, the effect of the intervention on lowering blood pressure was far more beneficial for hypertensive patients than normotensive patients. While many of the interventions lowered BP in normotensives, the effect was much greater on those diagnosed with hypertension in each of the studies that also included normotensives as a group. This further encourages the use of lifestyle/integrative interventions for hypertension management, as

activities and dietary changes that benefit the general population might have an even greater beneficial effect on hypertensive patients.

While robust evidence was revealed through this review, it was not without its limitations. It was difficult to make concrete conclusions based on the systematic reviews since each study varied widely in data collection methods. For example, the method and setting in which blood pressure was collected, and at what time point pre- and post- intervention BP were gathered varied. Follow-up times also varied and specific interventions that were similar usually were not exactly the same in design. Each systematic review explicitly mentioned the heterogeneity of the studies as a significant issue. For these reasons, the precision of the systematic reviews and the ability to draw conclusions was limited. Also, some of the studies allowed subjects to use medication during the study, while others did not, which may have had an effect on the results of the studies. Variability in diagnostic criteria for hypertension also contributed to heterogeneity amongst studies. The final sample for this review included many behavioral interventions, with less dietary and combination interventions. The comparatively limited evidence on dietary and combination interventions is a limitation. More studies on dietary and combination interventions and/or more balanced categories would have enhanced the results. This review was conducted by a single reviewer, and although measures were taken to prevent it, personal bias might be present.

Conclusion

Fourteen of the eighteen studies included in the final sample showed significant BP-lowering effects within hypertensive patients. This alone suggests that integrative modalities for independently managing HTN are effective and may be incorporated into practice and/or

recommendations. While the behavioral interventions showed the most promising evidence in reducing BP in hypertensive patients, with an average reduction of 7.8 mm Hg SBP and 6.1 mm Hg DBP, combination interventions were also largely effective. Overall, dietary interventions were not as effective at reducing BP, but specific dietary interventions, particularly salt reduction, are effective at reducing BP in hypertensives and should continue to be included in HTN recommendations.

We have several recommendations for future research in this area. We recommend that a standardized BP measurement be established. Type of measurement (manual versus automatic), location of measurement, ideally in a clinical setting, person responsible for measuring, ideally trained healthcare personnel, and frequency of measurement should be determined. This will reduce some of the heterogeneity amongst studies and allow further conclusions or cause-effect relationships to be more easily drawn. Furthermore, additional studies should be performed on the most effective BP-reducing integrative interventions to increase the growing, yet still limited, base of evidence supporting integrative medicine. More works are needed to determine if these results are sustainable long-term, over the course of years. For the purposes of this review, we recommend that the most effective evidence-backed integrative approaches, such as tai chi practice, music/music therapy, stress management and dietary counseling, and music be incorporated into practice guidelines and recommendations.

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Appendix

Author	Study Type	Year	Sample	Type of Intervention	Results	Limitations	Level of Evidence	Category	Randomization
Katsarou et al.	RCT	2014	36 adults with hypertension aged 50-79 years	Stress management; Dietary: Mediterranean diet. Subjects received a small amount of education/training.	A combined intervention of stress management techniques and Mediterranean diet education seems to be beneficial for BP reduction. Such interventions could possibly serve as a complementary treatment along with drug therapy or in the early treatment of high normal BP.	Small sample size; not double-blinded. Randomization confounded by the relative high rate of refusal to participate and inability to follow the intervention correctly. The average age of the intervention group was younger. The observed decrease in BP, although statistically significant, must be verified by future studies that will also assess out-of-office BP. This study cannot provide a direct association between the reduction of the perceived stress, the adherence to Mediterranean diet principles, and the reduction of BP because of the limited sample size and lack of measurement of potential mediators (e.g. cortisol and catecholamine).	2	Combination	Randomized into a control (n=20) and intervention group (n=16)
Kunikullaya et al.	RCT	2015	100 patients, 30-60 years old with stage I HTN or prehypertension, recruited from an outpatient department of a hospital	Music (with and without lifestyle modification)	Group 1 (intervention group) exhibited significant reduction in stress levels, diastolic BP and systolic BP decreased in Group 2 (control - lifestyle modification alone) after intervention. SBP remained the same in group 1, DBP dropped by 2 mm Hg. Passive listening to Indian music along with conventional lifestyle	Short term HRV analysis and BP before, during and immediately after the music intervention was not done on a single day to study the acute effects of music. This would have been really useful in this study. Music was done in the patient's setting of choice - a laboratory/controlled setting would have been better.	2	Behavioral	Randomized into two groups: lifestyle modification with music, and lifestyle modification alone

					modifications has a role in normalizing BP through autonomic function modification and thus can be used as a complementary therapy along with other lifestyle modifications.				
la Scala Teixeria et al.	RCT	2016	26 untrained men (14 normotensive, 12 hypertensive) between 20 and 59 years old, not currently engaged in a regular resistance training program, and of adequate heath and function to participate in the training sessions	Manual resistance training vs free weight resistance training	BP responses were similar between manual resistance training (MRT) and free-weight resistance training (FWRT) in both groups of men. MRT induced post-exercise hypotension (PEH) in the HT men in similar levels as FWRT. It was concluded that MRT is a viable and safe alternative for application of FWRT in NT and HT men, reducing the need for expensive equipment.	Lack of randomization in the order of interventions.	2	Behavioral	Into two groups: hypertensive and normotensive men
Staffileno, Tangney, & Fogg	RCT	2018	26 African American women aged 18-45 years with untreated prehypertention and internet access	DASH with online education modules	With respect to changes in clinical outcomes, systolic BP, diastolic BP, weight, and BMI did not differ across treatment groups. However, on average, there was a -1.2- and -5.6-lb weight loss in the DASH and PA groups, respectively.	This study had a somewhat high attrition rate, particularly in the physical activity group. Sample size is small and limited to young African-American women at risk for hypertension. They did not assess program engagement using the indicator of time spent logged into the Web site/program. Time spent on the Web site by participants may be a contributing factor to the overall success of the	2	Combination	Randomized into a physical activity alone (PA) group, and a DASH with online modules group

						intervention. Downloadable data were not available for the pedometer used, so steps were self-reported.			
Venturelli et al.	RCT	2015	40 elderly patients previously diagnosed with grade 1 HTN (20 males, 20 females, aged 65-74 years)	Relaxation training (RT) vs circuit training (ET) vs endurance training (RT)	All three groups experienced a reduction in SBP and DBP, but both ET and RT demonstrated a greater reduction of HTN in comparison to the subjects that performed RT. Moreover, HDL and LDL were significantly ameliorated after the ET treatment, while the effect on cholesterol was not significant for CT and RT.	Small sample size, mixed gender of sample, and potential effects of comorbidities such as type II diabetes.	2	Behavioral	Randomization into four groups with stratification for gender (n=10, 5 males and 5 females per group) - ET, RT, CT, and hypertensive controls
Wolff, Brorsson, Midlov, Sundquist, & Strandberg	RCT	2013	83 adult patients aged 20-80 years, diagnosed with HTN	Yoga	The yoga class group showed no improvement in blood pressure or self-rated quality of life, while in the yoga at home group there was a decline in diastolic blood pressure of 4.4 mm Hg ($p < 0.05$) compared to the control group. The yoga at home group showed significant improvement in self-rated quality of life compared to the control group	Only short-term effects are studied, more long-term studies are needed. Also, the data about how often the subjects were practicing yoga was self-reported. The participants were matched, not randomized. This was because they wanted to ensure similar SBP values at baseline for each group.	2	Behavioral	Randomized into three groups: yoga class with a yoga instructor, yoga at home, and a control group.
Wu, Zhang, Zhao, Chen, & Liu	RCT	2014	150 patients aged 18-74 with a history of hypertension for more than 3 months - all	Bushen Qinggan granule or decoction	Hypertension in three groups had no statistical difference. The study results suggest that blood pressure changes may not be the main function of the Chinese herb formula.	Translated into English; some translation issues may be present	2	Dietary	Randomized into three groups: taking the Bushen Qinggan

			subjects from the Cardiovascular Disease Clinic at the Xiyuan Hospital						granule, the Bushen Qinggan decoction, or control (placebo)
Zou, Dennis, & Parry	RCT	2016	618 Chinese Canadian adults, older than 45 years old	DASHNa-CC - a written manual, two classroom sessions, and one telephone call integrated with Traditional Chinese Medicine food therapy recommendations	It is feasible to deliver the DASHNa-CC intervention in a Chinese Canadian community. The DASHNa-CC intervention may decrease blood pressure and improve health-related quality of life for Chinese Canadians.	Might only be applicable to those in one cultural group.	2	Combination	Randomized into a control group and one intervention group receiving DASHNa-CC
Bahadoran, Mirmiran, Kabir, Azizi, & Ghasemi	Meta-analysis	2017	22 RCTs	Beetroot juice	SBP and DNP were significantly lower in the beetroot juice-supplemented groups than in the control groups. The mean difference of SBP was larger between beetroot juice-supplemented and control groups in the longer than in the shorter (>2 weeks versus <2 weeks) study durations. A positive correlation was found between beetroot juice doses and the mean differences of blood pressures.	There was a high level of heterogeneity, which was unavoidable because of the varying population groups of trials, varying doses of beetroot juice and NO3 contents of supplements, differences in study durations, and the physiologic and pathophysiologic status of participants. The search was also limited to English language and published records, possibly increasing the risk of publication bias.	1	Dietary	N/A

Cramer et al.	Meta-analysis	2014	7 RCTs (452 subjects total).	Yoga	Compared with usual care, very low-quality evidence was found for effects of yoga on systolic (mean difference -9.65 mm Hg) and diastolic (mean difference -7.22 mm Hg) blood pressure. Yoga may be a useful adjunct intervention to the management of HTN.	Much heterogeneity between studies. Evidence from studies was mostly low-quality - more high quality, larger studies are needed.	1	Behavioral	N/A
Kuhlmann et al.	Meta-analysis	2016	10 RCTs	Music	A trend towards a decrease in BP in hypertensive patients who received music interventions was found, but the review failed to establish a cause-effect relationship between music interventions and BP reduction.	Heterogenous sample of studies. Because the number of patients included in each RCT was so small and no formal comparison of the treatment effect between the music intervention and control group was possible, no firm causal conclusions could be drawn.	1	Behavioral	N/A
Uhlig, Patel, Ip, Kitsios, & Balk	Meta-analysis	2013	52 prospective comparative studies of self-monitored blood pressure (SMBP) monitoring with or without additional support versus usual care or an alternative SMBP monitoring intervention in persons with hypertension.	Some form of self-monitored BP monitoring vs. usual care	Because of the consistency of findings in higher quality studies, statistically significant findings in meta-analyses at 6 months, and a non-statistically significant finding at 12 months, the evidence for an improvement in BP using SMBP monitoring versus usual care is rated as moderate-strength and supports an improvement in BP with SMBP monitoring. There was a borderline statistically significant benefit of achieving a predefined BP target with SMBP monitoring versus usual care at 6 months, which lost significance at 12 months.	There was a large degree of variability within SMBP protocols in the studies, transmission of and response to BP data, and types of additional support provided in the studies. Because no two studies used the same method of additional support, and SMBP protocols differed in each study, it was impossible to draw firm conclusions about the effects of specific methods or particular components of additional support. Studies also differed in medication protocols, and whether BP management/measuring was at home or in a clinical setting. Some of the evidence used in the meta-analysis was level C or below. The researchers were	1	Behavioral	N/A

						able to discern that SMBP lowers BP, but its sustainability and long-term clinical effectiveness remain uncertain.			
Adler et al.	Systematic Review	2014	8 studies (5 on hypertensives)	Dietary: reduced salt intake	Advice to reduce salt showed reduction in systolic blood pressure in hypertensives (MD -4.14 mm Hg), but no difference in diastolic blood pressure	Heterogeneity between studies. Follow up was one of the biggest areas of heterogenicity. Risk of bias in studies; some researchers unable to be contacted. Quality of evidence limited in some studies.	1	Dietary	N/A
Cramer	Systematic Review	2015	10 RCTs (looking at yoga and hypertension section only)	Yoga	There is evidence that yoga, especially yogic meditation and yogic breathing, can be a safe and useful adjunct intervention in the management of HTN - but not of prehypertension. Yoga should be considered as an adjunct intervention only and not be regarded as an alternative to antihypertensive medication. Although it's still a matter of investigation, increases in parasympathetic activity and decreases in excess sympathetic activity seem to be key mechanisms by which yogic breathing, meditation, and perhaps postures (asana) counteract HTN.	Not formatted well. Stronger methodology needed.	1	Behavioral	N/A
Hartley et al.	Systematic Review	2014	11 trials (800 total adult participants) and 2 ongoing studies	Yoga	The limited evidence comes from small, short-term, low quality studies. There is some evidence that yoga has favorable effects on DBP. However, these results should be considered exploratory and should be interpreted with caution.	Substantial heterogeneity between studies - made it impossible to combine studies statistically for SBP and total cholesterol.	1	Behavioral	N/A

Hartley, Flowers, Soo Lee, Ernst, & Rees	Systematic Review	2014	13 RCTs. 11 of the studies examined the effect of tai chi on BP	Tai chi	In 6 of the trials that included BP, tai chi significantly reduced SBP. In 2 trials, there was so statistically significant effect on SBP. In one study there was a statistically significant increase in SBP. 7 trials measured DBP. In 3 trials, there was also a significant reduction in DBP. One trial significantly increased DBP. 3 trials had no statistically significant effect on DBP.	Heterogeneity between studies. There was some risk of bias in the studies. Some components of the studies that the authors of the review were attempting to measure were unclear.	1	Behavioral	N/A
Hartley et al.	Systematic Review	2015	11 competed RCTs (1369 total participants). Specifically, 6 trials provided data that could be used to examine the effects of qigong on BP.	Qigong	Reductions in SBP and DBP were seen in three and two trails, respectively.	Trials were heterogenous. The authors were unable to ascertain the risk of bias in nine trials published in Chinese. No meta-analysis was performed as trials were small and at significant risk of bias.	1	Behavioral	N/A
Xiong et al.	Systematic Review	2014	9 RCTs (1012 hypertensive patients total)	Ginkgo biloba extract	6 trials demonstrated potential positive effect of GBE as complementary therapy on BP reduction when compared with antihypertensive drug therapy; however, it was not associated with a statistically significant effect on both SBP and DBP reduction in 3 other trials.	There were many methodological limitations and significant clinical heterogeneity. Most of the trials did not report adverse effects, and the safety of gingko biloba extract is still uncertain.	1	Dietary	N/A